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THE CONTRIBUTION OF OPERATIVITY TO NAMING CAPACITY IN APHASIC PATIENTS

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Abstract—Matched groups of anterior aphasics, posterior aphasics, and a control group of non-aphasic patients were given an extensive naming test in order to determine the contribution of a number of variables to naming facility. Of particular interest was whether those elements described by Piaget as *operative*—objects, parts of objects, and other entities which can be readily grasped, manipulated, and operated upon—were easier to name than those which can only be known in a *figurative* way. When word frequency was controlled for, it was found that elements which are relatively operative were more easily named than elements which are relatively figurative. The results are discussed in terms of the mechanisms which govern naming in aphasic and normal individuals.

DIFFICULTY in producing on demand the names of objects and parts of objects is found in several varieties of aphasia [1] and the mechanisms governing this capacity are accordingly of considerable interest. Despite scattered evidence that factors such as picturability [2], opening sounds [3], animateness [4, 5], semantic category [6, 7], concreteness [8] and the time when the name was learned [9, 10] may contribute to naming competence, a consistent role played by factors other than word frequency [3, 11, 12, 13] has yet to be demonstrated. The present investigation was designed to determine whether such factors can indeed be identified.

It was noted informally that patients asked to name items within a given category (like body parts) required less effort and were more successful in naming instances which could be easily handled and which were relatively discrete and separate entities (like nose or finger) than in naming instances of equal frequency and articulability which could not easily be grasped and which were continuous with the surroundings context (like hip or chin). A plausible explanation followed from the view of PIAGET [14] that individuals construct their knowledge of the world by acting upon the objects in the world, by manipulating, ordering and otherwise transforming them. Objects which can be readily "operated upon" will be known through a variety of actions and sensory modalities. Their names can be more easily accessed than names of equally familiar elements which are known only in limited ways (arousing few potential actions and appealing exclusively to the visual sense) and do not engage an equivalent number of associations.

To test the contribution of manipulability (in Piaget's terms, *operativity*) to naming, several pictures were drawn, each containing some objects and elements which were relatively *operative* (discrete and readily manipulated), others which were equally familiar and also picturable, yet relatively non-operative or *figurative*. It was decided to present several elements arranged in one large picture instead of single pictures of each element. By using a composite picture, it was possible to depict *parts* of objects, to compare naming facility across a variety of pictorial environments, and to reduce the abstractness [8] of the task by presenting elements in their customary context. For example, by presenting a picture of a person and designating various components of the picture, it was possible to determine the ease of naming such parts as *hip, waist, earlobe, shoulder,* etc.; these parts would be extremely difficult to depict in isolation.

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In addition to the contributions of word frequency and operativity to naming, information was also obtained on differences between patients with anterior and posterior lesions, and on the relative difficulty of naming objects which are found in markedly different settings. This last question was of interest because of claims that the semantic category of the element [6, 7] or the animateness of the element may contribute to the case of naming.

METHOD

Subjects

The subjects were 11 aphasic patients whose lesions were located exclusively in the anterior (frontal lobe) area of the dominant hemisphere, 11 aphasic patients whose lesions were located exclusively in the posterior (temporal and parietal) area of the dominant hemisphere and 11 control patients who were hospitalized for non-neurological reasons. The patients were all right-handed males at the Boston Veterans Administration Hospital; each of the groups were approximately matched in median age (53), socio-economic background (working class), educational level (high school). All aphasic patients on the ward during a three month period whose lesions were stable and could be satisfactorily localized according to evidence from brain scans, surgeon's reports, EEG's, field defects, and clinical observations were included in the study. This method of selection was designed to eliminate any systematic bias in the composition of the groups: A review of the subjects' severity rating on the Boston Diagnostic Aphasia Test [15] confirmed the equivalence of the groups.

Materials

An artist produced as stimuli four different pictures representing the interior of a house, a city street, the body of a woman (with a close-up of a head on a separate sheet) and a scene in the country. Each picture was drawn in black ink on a 8½ in. × 13 in. piece of white cardboard. The pictures contained many objects, portions of objects, and other elements ordinarily found in that setting. For example, the interior of the house had a fireplace, mantle, telephone, bookcase, rug, desk, table, chair, lamp, vase, clock, ceiling, floor, walls, door, and numerous other elements. A list of all the elements in the pictures was drawn up and this list was shown with the pictures to four psychologically-trained judges. The judges were asked to classify the different elements in the picture as relatively "figurative" or relatively "operative". Operative elements were defined as those which were relatively discrete and separate from the surrounding context, easy to manipulate, firm to the touch, easily available to several sense modalities. Figurative elements were defined as those which did not meet these criteria but were nonetheless picturable; elements which were continuous with their surrounding context, did not lend themselves to ready manipulation, were difficult to grasp and not firm to the touch, known primarily by their visual configuration.

Items on which there was disagreement among judges were dropped from consideration and those on which three of the four judges agreed were then examined in terms of a number of criteria, including length, difficulty of pronunciation, and frequency. For each picture, six words at each of three frequency levels were chosen [16]. The same judges were then asked to indicate which three of the words in each category were more figurative, which were more operative. All of the judges agreed on 94 per cent of the items and three of the four judges agreed on the remaining elements. After this procedure had been completed eighteen items had been isolated for naming in each picture: three operative and three figurative items at each of the three levels of frequency, matched insofar as possible in length and pronunceability. To give a few examples, in the picture of the interior, the ceiling was considered figurative, the vase operative; in the picture of the body, a finger was operative, a hip figurative; in the picture in the city, a hydrant was operative and a curb figurative; in the picture in the country, a rock was operative and a cloud was figurative. Every attempt was made to equate the words in frequency, length, and difficulty of articulation. The average frequency in each category is given in Table 1.

Procedure

A subject was shown one of the pictures and told that he was to name elements which the experimenter

Table 1. Mean frequencies of words used in naming task

Operativity	High*	Medium†	Low‡
Relatively figurative	1116	305	54
Relatively operative	1058	319	37

Note: Frequencies cited are the number of mentions in the total corpus taken from *The American Heritage Word Frequency Book* [16].

*Range 400–2700.
†Range 80–430.
‡Range 41–86.

would designate. To determine if the subject understood the instructions he was shown an item not included in the test and given practice in naming it. When the subject demonstrated comprehension of the task, he was shown the first item and asked to name it. The item was designated with a hand pointer for approximately one second; if the item was very small (e.g. toenail or keyhole) the pointer remained on the item for a second; if the item was larger, (e.g. cloud or tree) the pointer passed quickly over the relevant portions of the picture. The subject was then asked to name the item and latency to response was recorded. If he had not answered correctly after fifteen sec, he was encouraged to take a guess. If he had not answered correctly after 30 sec, he was given four choices; the correct name, a word which might be semantically confused with the target, a word which might be acoustically confused with the target, and a word with no obvious associations to the target. With a few exceptions (plurals were acceptable for some items, *ray* or *sunray*, *lobe* or *earlobe* were both considered correct) the subject had to give the precise name which had been chosen in advance. Neither synonyms nor literal paraphasias were acceptable. Since some anterior patients had articulatory difficulties and some posterior patients had jargon-like or paraphasic tendencies, this strict criterion may have lowered the scores, but presumably did not prejudice the results for or against either of the subject groups. If the subject had difficulty articulating the word on multiple choice, he was allowed to point to a finger raised as the word was enunciated by the experimenter.

Normally the task was administered in two half-hour sessions on successive days. The controls and some subjects who were only mildly aphasic completed the task in one session; some severely impaired patients took three sessions to complete the task. All relevant variables such as order of presentation of the picture, order of words within each picture, and presentation of multiple choices were counterbalanced.

RESULTS

Each subject's answers were scored in two ways: number of correct responses given during the 30-sec period following designation of the element; number of correct responses given when recognition of the correct name from multiple choice was added to the first score. The normal controls gave the correct answer immediately in nearly all cases; on only 3 of 792 items was it necessary to give the four choices. There was no difference for this control group between the operative and figurative items in the number of correct answers or in the average latency. The aphasic subjects made very few errors on multiple choice (44 errors on the 420 items where a choice was necessary) and those errors that were made did not fall into a consistent pattern. This result indicates that aphasics had little difficulty in recognizing the elements and their names, and that they differed from normal subjects primarily in the ease with which they could spontaneously produce the name. Accordingly the scores of critical interest were the number of correct answers given by subjects before the presentation of multiple choices. These results are summarized in Fig. 1.

A repeated measures analysis of variance with frequency and operativity as within-subject variables and subject group as between-subject variable was performed on these scores. This analysis revealed that there was a significant effect of subject group ($F = 13$; $p<0{\cdot}01$); a significant effect of operativity ($F = 69{\cdot}85$; $p<0{\cdot}01$) and a significant effect of

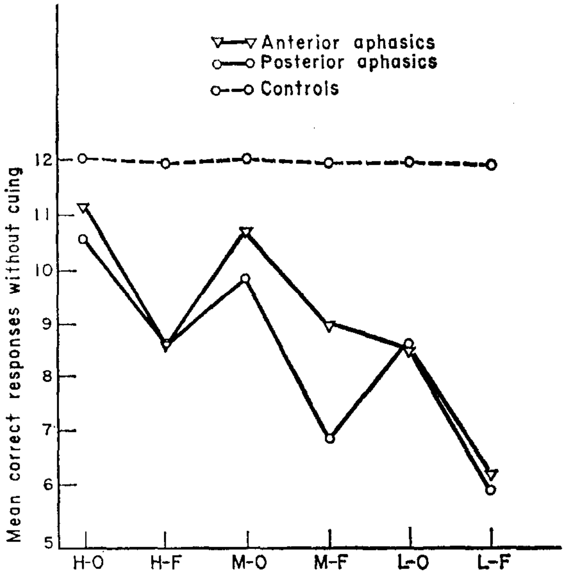

FIG. 1. Mean number of correct responses given by the three subject groups during the 30-sec period before a cue was provided. Responses are plotted in terms of kind of element named (operative or figurative) and level of word frequency (high, middle, and low).

word frequency ($F = 36{\cdot}33$; $p<0{\cdot}01$). There was also a significant interaction of subject group and degree of operativity ($F = 16{\cdot}91$; $p<0{\cdot}01$) and a significant interaction of subject group and frequency ($F = 8{\cdot}50$; $p<0{\cdot}01$). These results indicated that frequency and operativity both make substantial contributions to ease in naming objects, with operativity making the larger contribution; and that there is an interaction between subject group and these independent variables, due to the fact that each factor makes a more significant contribution when the patient has language difficulties.

Since the normal group's scores did not overlap with the scores of the aphasic subjects, a separate analysis of variance was performed solely on the scores of the two aphasic groups. This analysis revealed that operativity was a significant factor ($F = 66{\cdot}35$; $p<0{\cdot}01$) as was frequency ($F = 50{\cdot}96$, $p<0{\cdot}01$); there were no interactions and no significant difference between the groups. It should be noted that the anterior aphasics did perform slightly better in each of the conditions.

A number of other analyses were performed on the data in order to determine the influence of other variables. Since none of these analyses yielded notable findings, their results can be quickly summarized.

It had been hypothesized that elements included in one or another of the pictures might prove easier for the patients to name than the elements in the other settings but there was no significant difference in the difficulty of the four pictures. The order of difficulty for both anterior and posterior patients was the same: body parts were the easiest to name, the interior of a room was next, the country scene and the urban exterior were the most difficult. This ordering can be accounted for in terms of the patient's presumed familiarity with each of these settings. A significant difference between the easiest and hardest category can be shown non-parametrically but no importance is attached to this artifactual dif-

Table 2. Principal kinds of naming errors made by aphasic patients

Aphasic group	Metonym or synonym*	Naming the item next to designated item	Semantic paraphasia	Literal paraphasia	Visual confusion†	Perseveration‡	Description§	Other
	%	%	%	%	%	%	%	%
Anterior aphasics	44	5·5	14·5	7·5	4	3·5	8·5	12·5
Posterior aphasics	19	3·5	21	18·5	·5	10·5	8	19

*Response was an alternative name for the designated item, a part of the item instead of the whole item, or a larger element in which the designated item was included.

†Response was the name of an item with a physical resemblance to the designated item.

‡Response was repetition of response given for one of four preceding items.

§Response was a terse or circumlocutory description of the function or nature of the designated item.

ference. Analyses were done to determine whether there were any differences in response latencies between subject groups or classes of stimuli but again no significant differences were found.

On the items on which multiple choice was required, aphasic subjects made only 44 errors: 22 semantic, 11 acoustic, and 11 random. Patterns among anterior and posterior aphasics was similar, with both groups making an equal number of errors and making more semantic than acoustic choices. Naming errors were further analyzed by classifying all the incorrect responses given initially by subjects according to a scheme on which adequate inter-judge reliability (0·86) measures have been obtained. Results of this analysis are given in Table 2. It should be noted that the posterior aphasics had a significantly larger proportion of paraphasias and perseverative responses while the anterior aphasics gave a significantly greater number of synonymous and metonymic responses which were reasonably appropriate for the designated item yet not the required answer ($t \geqslant 1{\cdot}8$, $p < 0{\cdot}05$). These results are consistent with the better preserved comprehension of anterior patients and their tendency to favor substantives in their spontaneous speech.

The contribution of operativity to naming was evident in the performance of most subjects, but particularly dramatic in those subjects who had some difficulty in initiating speech. These subjects would search for any kind of stimulus or cue which would get them started. They would look around the room or out the window for the object in question, feel the relevant body part, even run their hands back and forth across the picture. Clearly these subjects believed that any kind of physical contact with the element in question would aid in retrieving and articulating its name. Sometimes the gestures were quite striking; one subject stamped his foot as he tried to say the target word *foot;* another pulled every body part before successfully naming it. Three subjects succeeded in naming all the operative elements in one of the frequency categories and none of the figurative elements. The only figurative elements which were more easily named by most subjects than the matching operative elements were *sun* and *moon*. This result may be due to the great frequency and pervasiveness of these elements, to the intense sensory stimulation which they provide, to their strong affective components or their frequent anthropomorphization and objectivication within the culture.

DISCUSSION

The principal results of the study are readily summarized. Matched groups of anterior and posterior aphasics did not differ significantly in the number or types of items which they had difficulty in naming on confrontation. This result is consistent with the finding that naming deficits have little localizing value [1, 8, 17]. Those items which were easiest for both groups to name were those whose names occur frequently in the English language and those which were relatively operative, i.e. those objects in the world which lend themselves to manipulation, transformation, and have appeal to multiple sensory modalities. The setting in which the object was typically found did not make a substantial difference, although those settings which would be relatively more familiar—a body and the interior of a house—were somewhat easier to deal with than the less familiar scenes of an urban exterior and the country-side. The absolute number of errors on multiple choice was low and the types of errors made during uncued naming were consistent with the aphasics' clinical pictures: the anterior patients had a higher proportion of appropriate substantives while the posterior patients issued more paraphasic and perseverative responses.

Since aphasias in which naming difficulty is the most prominent feature are generally associated with posterior pathology [15], and since the anterior aphasics gave generally appropriate responses, it may be asked whether anterior aphasics have a genuine naming difficulty. Indeed, the results of the error analysis suggest that if the anterior patients had simply been asked to describe the composite picture, little naming difficulty would have been detected. Yet, when the task is made somewhat more structured, by requiring a specific name for an isolated element, both groups of aphasics have subnormal performance. Such naming difficulty might be explained as an impairment of the abstract attitude required in confrontation naming [8]. However, the difficulties in defining and operationalizing "abstractness", and the fact that the elements were depicted in their customary environment renders a Goldsteinian interpretation of the results unsatisfactory. A view in which word frequency and element operativity is taken into account may offer a more adequate explanation of naming performance. As word frequency has been widely reviewed [2, 3, 11, 12], this discussion will focus on the concept of operativity.

Following Piaget it may be that naming depends upon the capacity to arouse some subset of the actions or sensory experiences (schemes) normally involved in activity with the object [18]. The normal subject may instantaneously arouse these schemes even in the absence of the object or may arrive at the name through the arousal of a single scheme. In contrast the aphasic patient may have greater difficulty in initiating this process or may need to activate more schemes before producing the required name. When the physical object is rendered pictorially, it is plausible to assume that aspects of this recognitory and naming process are re-enacted [19, 20]. It follows that operative elements, which arouse a large set of acts and associations, are more likely to be named than figurative elements, which involve only a limited number of schemes.

It seems plausible to postulate that naming on confrontation involves the conveying of visual information to the cross-modal association area at the intersection of the temporal, parietal, and occipital lobes [21]. At this point, all sensory and motor schemes aroused by the visual image of the object can be drawn on as the individual attempts to name it. In the case of letters, colors, and perhaps written words which arouse few if any non-visual associations [21, 22] the name may be evoked by a direct connection between the visual image and some kind of acoustic-motor engram. Naming of these written symbols appears more susceptible to disruption by focal lesion or by cortical disconnections than naming of those visual images which arouse multiple motor and sensory association [21]. A similar argument may account for the relative robustness of the names of operative elements. These can be aroused through several sensory modalities, while the names of figurative elements depend primarily on associations within the visual modality. Further evidence of the contribution of operativity to naming are the findings that objects are more likely to be remembered than pictures of objects or names of objects [23]; and that children are more successful at naming operative than figurative elements [24]. Perhaps this Piagetian concept will prove as fruitful in the realm of neuropsychology as it has been in developmental psychology [25, 26].

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Resumé—Dans le but de déterminer la participation d'un certain nombre de variables dans la tâche de dénomination, on a donné un large test de dénomination à des groupes appariés de sujets aphasiques antérieurs, de sujets aphasiques postérieurs et à un groupe contrôle de malades non-aphasiques. Il est particuliérement intéressant de savoir si ces éléments décrits par PIAGET comme *opératoires*—objets, parties des objets et autre entités qui peuvent être aisément saisis, manipulés et sur lesquels des opérations peuvent s'exercer—sont plus faciles à nommer que ceux qui peuvent être seulement connus de façon *figurative*. Lorsque la fréquence des mots était contrôlée, on constatait que les éléments qui sont relativement opératoires étaient plus aisément dénommés que les éléments qui sont relativement figuratifs. On discute ces résultats en termes de mécanismes gouvernant la dénomination chez les aphasiques et chez les normaux.

Zusammenfassung—Entsprechenden Gruppen von Aphasikern des vorderen Hirnabschnitts, Aphasikern des hinteren Hirnbereichs und einer Kontrollgruppe nicht aphasischer Patienten wurde ein umfangreicher Benennungstest vorgelegt, um die Verteilung einer Reihe von variablen Faktoren für die Benennungsfähigkeit zu bestimmen. Von besonderem Interesse war, ob jene Elemente, die von Piaget als 'operative' (handhabbare) Objekte beschrieben wurden, als Teile solcher Objekte oder als andere Ganzheiten, die leicht ergriffen, gehandhabt und betätigt werden können, einfacher zu bezeichnen seien als solche, die nur in übertragenem Sinn gewußt werden. Die Prüfung auf Worthäufigkeit ergab, daß Elemente, die verhältnismäßig 'operative' (handhabbar) waren, leichter benannt wurden als Elemente, die mehr sinnbildlich gebraucht wurden. Die Ergebnisse werden im Hinblick auf die Mechanismen diskutiert, die das Benennen bei Aphasikern und bei Normalpersonen regeln.